CLAIMS

What is claimed is:

1. A method for detecting data from K data signals transmitted over a shared spectrum in a code division multiple access format, the method comprising:

receiving and sampling a combined signal over the shared spectrum as a plurality of received vector versions, the combined signal including the K transmitted data signals;

producing a plurality of system matrices and an associated covariance matrix using codes and estimated impulse responses of the K data signals, each system matrix corresponding to a received vector version;

extending and approximating the system and covariance matrices as block circulant matrices;

determining a diagonal matrix of each of the extended and approximated system and covariance matrices, using a block column of the extended and approximated system and covariance matrices;

extending and taking a Fourier transform of each received vector version;

taking products of the diagonal matrices and the extended received vector versions;

summing the products; and

estimating data of the K data signals using an inverse Fourier transform and the summed products.

2. The method of claim 1 wherein the Fourier transforms are performed using a prime factor algorithm fast Fourier transform.

3. The method of claim 1 wherein each received vector version corresponds to a different reception antenna.

4. The method of claim 1 wherein the combined signal is sampled at a multiple of a chip rate of the K data signals and each received vector version corresponds to a different chip rate multiple.

5. The method of claim 1 wherein the K data signals are received over a plurality of antennas and sampled at a multiple of a chip rate of the K data signals and each received vector version corresponds to a different antenna and chip rate multiple combination.

6. The method of claim 1 further comprising partitioning the diagonal matrices into a plurality of partitions.

7. The method of claim 1 wherein the estimating data of the K data signals includes performing LU decomposition , forward substitution and backward substitution.

8. The method of claim 1 wherein the estimating data of the K data signals includes performing Cholesky decomposition, forward substitution and backward substitution.

9. The method of claim 1 wherein LU decomposition or Cholesky decomposition is performed on the diagonal of the covariance matrix.

10. A user equipment for detecting data from K data signals transmitted over a shared spectrum in a code division multiple access format, the user equipment comprising:

means for receiving and sampling a combined signal over the shared spectrum as a plurality of received vector versions, the combined signal including the K transmitted data signals;

means for producing a plurality of system matrices and an associated covariance matrix using codes and estimated impulse responses of the K data signals, each system matrix corresponding to a received vector version;

means for extending and approximating the system and covariance matrices as block circulant matrices;

means for determining a diagonal matrix of each of the extended and approximated system and covariance matrices, using a block column of the extended and approximated system and covariance matrices;

means for extending and taking a Fourier transform of each received vector version;

means for taking products of the diagonal matrices and the extended received vector versions;

means for summing the products; and

means for estimating data of the K data signals using an inverse Fourier transform and the summed products.

11. The user equipment of claim 10 wherein the Fourier transforms are performed using a prime factor algorithm fast Fourier transform.

12. The user equipment of claim 10 wherein each received vector version corresponds to a different reception antenna.

13. The user equipment of claim 10 wherein the combined signal is sampled at a multiple of a chip rate of the K data signals and each received vector version corresponds to a different chip rate multiple.

14. The user equipment of claim 10 wherein the K data signals are received over a plurality of antennas and sampled at a multiple of a chip rate of the K data signals and each received vector version corresponds to a different antenna and chip rate multiple combination.

15. The user equipment of claim 10 further comprising means for partitioning the diagonal matrices into a plurality of partitions.

16. The user equipment of claim 10 wherein the estimating data of the K data signals includes performing LU decomposition , forward substitution and backward substitution.

17. The user equipment of claim 10 wherein the estimating data of the K data signals includes performing Cholesky decomposition, forward substitution and backward substitution.

18. The user equipment of claim 10 wherein LU decomposition is performed on the diagonal of the covariance matrix.

19. The user equipment of claim 10 wherein Cholesky decomposition is performed on the diagonal of the covariance matrix.

20. A user equipment for detecting data from K data signals transmitted over a shared spectrum in a code division multiple access format, the user equipment comprising:

an antenna and a sampling device for receiving a combined signal over the shared spectrum as a plurality of received vector versions, the combined signal including the K transmitted data signals;

a plurality of compute sub-system matrix blocks for producing a plurality of system matrices using estimated impulse responses of the K data signals, each system matrix corresponding to a received vector version;

a compute covariance matrix block for producing a covariance matrix associated with the system matrices;

a plurality of extension blocks for extending the system and covariance matrices;

a plurality of first block column devices for approximating the extended system and covariance matrices as block circulant matrices;

a plurality of block Fourier transform devices for determining a diagonal matrix of each of the extended and approximated system and covariance matrices, using the block column of the extended and approximated system and covariance matrices;

an extension device for extending each received vector version;

a block Fourier transform device for taking a Fourier transform of each received vector version;

a plurality of multipliers for taking products of the diagonal matrices and the extended received vector versions;

a summer for summing the products; and

a block inverse Fourier transform device for estimating data of the K data signals using an inverse Fourier transform and the summed products.

21. The user equipment of claim 20 wherein the Fourier transforms are performed using a prime factor algorithm fast Fourier transform.

22. The user equipment of claim 20 wherein each received vector version corresponds to a different reception antenna.

23. The user equipment of claim 20 wherein the combined signal is sampled at a multiple of a chip rate of the K data signals and each received vector version corresponds to a different chip rate multiple.

24. The user equipment of claim 20 wherein the K data signals are received over a plurality of antennas and sampled at a multiple of a chip rate of the K data signals and each received vector version corresponds to a different antenna and chip rate multiple combination.

25. The user equipment of claim 20 further comprising partitioning device for partitioning the diagonal matrices into a plurality of partitions.

26. The user equipment of claim 20 further comprising a LU decomposition device for performing LU decomposition on the diagonal of the covariance matrix and a forward substitution and a backward substitution devices for producing an inverse Fourier transform of the estimated data vector.

27. The user equipment of claim 20 further comprising a Cholesky decomposition device for performing Cholesky decomposition on the diagonal of the covariance matrix and a forward substitution and a backward substitution devices for producing an inverse Fourier transform of the estimated data vector.

28. A base station for detecting data from K data signals transmitted over a shared spectrum in a code division multiple access format, the base station comprising:

means for receiving and sampling a combined signal over the shared spectrum as a plurality of received vector versions, the combined signal including the K transmitted data signals;

means for producing a plurality of system matrices and an associated covariance matrix using codes and estimated impulse responses of the K data signals, each system matrix corresponding to a received vector version;

means for extending and approximating the system and covariance matrices as block circulant matrices;

means for determining a diagonal matrix of each of the extended and approximated system and covariance matrices, using a block column of the extended and approximated system and covariance matrices;

means for extending and taking a Fourier transform of each received vector version;

means for taking products of the diagonal matrices and the extended received vector versions;

means for summing the products; and

means for estimating data of the K data signals using an inverse Fourier transform and the summed products.

29. The base station of claim 28 wherein the Fourier transforms are performed using a prime factor algorithm fast Fourier transform.

30. The base station of claim 28 wherein each received vector version corresponds to a different reception antenna.

31. The base station of claim 28 wherein the combined signal is sampled at a multiple of a chip rate of the K data signals and each received vector version corresponds to a different chip rate multiple.

32. The base station of claim 28 wherein the K data signals are received over a plurality of antennas and sampled at a multiple of a chip rate of the K data signals and each received vector version corresponds to a different antenna and chip rate multiple combination.

33. The base station of claim 28 further comprising means for partitioning the diagonal matrices into a plurality of partitions.

34. The base station of claim 28 wherein the estimating data of the K data signals includes performing LU decomposition , forward substitution and backward substitution.

35. The base station of claim 28 wherein the estimating data of the K data signals includes performing Cholesky decomposition, forward substitution and backward substitution.

36. The base station of claim 28 wherein LU decomposition is performed on the diagonal of the covariance matrix.

37. The base station of claim 28 wherein Cholesky decomposition is performed on the diagonal of the covariance matrix.

38. A base station for detecting data from *K* data signals transmitted over a shared spectrum in a code division multiple access format, the base station comprising:

an antenna and a sampling device for receiving a combined signal over the shared spectrum as a plurality of received vector versions, the combined signal including the *K* transmitted data signals;

a plurality of compute sub-system matrix blocks for producing a plurality of system matrices using estimated impulse responses of the K data signals, each system matrix corresponding to a received vector version;

a compute covariance matrix block for producing a covariance matrix associated with the system matrices;

a plurality of extension blocks for extending the system and covariance matrices;

a plurality of first block column devices for approximating the extended system and covariance matrices as block circulant matrices;

a plurality of block Fourier transform devices for determining a diagonal matrix of each of the extended and approximated system and covariance matrices, using the block column of the extended and approximated system and covariance matrices;

an extension device for extending each received vector version;

a block Fourier transform device for taking a Fourier transform of each received vector version;

a plurality of multipliers for taking products of the diagonal matrices and the extended received vector versions;

a summer for summing the products; and

a block inverse Fourier transform device for estimating data of the K data signals using an inverse Fourier transform and the summed products.

39. The base station of claim 38 wherein the Fourier transforms are performed using a prime factor algorithm fast Fourier transform.

39. The base station of claim 38 wherein each received vector version corresponds to a different reception antenna.

40. The base station of claim 38 wherein the combined signal is sampled at a multiple of a chip rate of the K data signals and each received vector version corresponds to a different chip rate multiple.

41. The base station of claim 38 wherein the K data signals are received over a plurality of antennas and sampled at a multiple of a chip rate of the K data signals and each received vector version corresponds to a different antenna and chip rate multiple combination.

42. The base station of claim 38 further comprising partitioning device for partitioning the diagonal matrices into a plurality of partitions.

43. The base station of claim 38 further comprising a LU decomposition device for performing LU decomposition on the diagonal of the covariance matrix and a forward substitution and a backward substitution devices for producing an inverse Fourier transform of the estimated data vector.

44. The base station of claim 38 further comprising a Cholesky decomposition device for performing Cholesky decomposition on the diagonal of the covariance matrix and a forward substitution and a backward substitution devices for producing an inverse Fourier transform of the estimated data vector.

45. A method for receiving a plurality of data signals transmitted over a shared spectrum in a code division multiple access communication system, the method comprising:

receiving and sampling a combined signal having the plurality of transmitted data signals to produce a received vector;

determining a channel response for the plurality of transmitted data signals;

determining a system response matrix using the determined channel response and codes of the transmitted data signals;

determining a covariance matrix using the system response matrix;

extending the received vector, the system response matrix and the determined covariance matrix;

taking a block discrete Fourier transform of a block column of the extended covariance matrix

taking a block discrete Fourier transform of a block column of the system response matrix;

taking a block discrete Fourier transform of the received vector; and

determining an extended data vector using the block discrete Fourier transforms.

46. The method of claim 45 further comprising partitioning the block discrete Fourier transforms.

47. The method of claim 45 further comprising performing LU decomposition on the block Fourier transforms.

48. A user equipment for detecting data from K data signals transmitted over a shared spectrum in a code division multiple access format, the user equipment comprising:

an antenna and a sampling device for receiving and sampling a combined signal having the plurality of transmitted data signals to produce a received vector;

a channel estimation device for determining a channel response for the plurality of transmitted data signals;

a compute block matrix device for determining a system response matrix using the determined channel response and codes of the transmitted data signals;

a compute covariance matrix device for determining a covariance matrix using the system response matrix;

a plurality of extend devices for extending the received vector, the system response matrix and the determined covariance matrix;

a block discrete Fourier transform device for taking a block discrete Fourier transform of a block column of the extended covariance matrix

a block discrete Fourier transform device for taking a block discrete Fourier transform of a block column of the system response matrix;

a block discrete Fourier transform device for taking a block discrete Fourier transform of the received vector; and

a circuit for determining an extended data vector using the block discrete Fourier transforms.

49. The user equipment of claim 48 further comprising a partitioning device for partitioning the block discrete Fourier transforms.

50. The user equipment of claim 48 wherein the circuit comprising a LU decomposition device for performing LU decomposition on the block Fourier transforms.

51. A user equipment for detecting data from K data signals transmitted over a shared spectrum in a code division multiple access format, the user equipment comprising:

means for receiving and sampling a combined signal having the plurality of transmitted data signals to produce a received vector;

means for determining a channel response for the plurality of transmitted data signals;

means for determining a system response matrix using the determined channel response and codes of the transmitted data signals;

means for determining a covariance matrix using the system response matrix;

means for extending the received vector, the system response matrix and the determined covariance matrix;

means for taking a block discrete Fourier transform of a block column of the extended covariance matrix

means for taking a block discrete Fourier transform of a block column of the system response matrix;

means for taking a block discrete Fourier transform of the received vector; and

means for determining an extended data vector using the block discrete Fourier transforms.

52. The user equipment of claim 51 further comprising means for partitioning the block discrete Fourier transforms.

56. The base station of claim 54 wherein the circuit comprising a LU decomposition device for performing LU decomposition on the block Fourier transforms.

57. A base station for detecting data from *K* data signals transmitted over a shared spectrum in a code division multiple access format, the base station comprising:

means for receiving and sampling a combined signal having the plurality of transmitted data signals to produce a received vector;

means for determining a channel response for the plurality of transmitted data signals;

means for determining a system response matrix using the determined channel response and codes of the transmitted data signals;

means for determining a covariance matrix using the system response matrix;

means for extending the received vector, the system response matrix and the determined covariance matrix;

means for taking a block discrete Fourier transform of a block column of the extended covariance matrix

means for taking a block discrete Fourier transform of a block column of the system response matrix;

means for taking a block discrete Fourier transform of the received vector; and

means for determining an extended data vector using the block discrete Fourier transforms.

58. The base station of claim 57 further comprising means for partitioning the block discrete Fourier transforms.

59. The base station of claim 57 wherein the means for determining an extended data vector comprising a LU decomposition device for performing LU decomposition on the block Fourier transforms.

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NEW APPLICATION DOCUMENT INDEX SHEET

- [ ] TRNA ________ Transmittal New Application
- [ ] SPEC ________ Specification
- [ ] CLM ________ Claims
- [x] ABST ___/___ Abstract
- [ ] DRW ________ Drawings
- [ ] OATH ________ Oath or Declaration
- [ ] ADS ________ Application Data Sheet
- [ ] A... ________ Amendment Including Elections
- [ ] A.PE ________ Preliminary Amendment
- [ ] REM ________ Applicant Remarks in Amendment
- [ ] IDS ________ IDS Including 1449
- [ ] 371P ________ PCT Papers in a 371P Application
- [ ] FOR ________ Foreign Reference
- [ ] NPL ________ Non-Patent Literature
- [ ] FRPR ________ Foreign Priority Papers
- [ ] ARTIFACT ________ Artifact
- [ ] LET. ________ Misc. Incoming Letter
- [ ] IMIS ________ Misc. Internal Document
- [ ] TRREISS ________ Transmittal New Reissue Application
- [ ] PROTRANS ________ Translation of Provisional in Nonprovisional
- [ ] BIB ________ Bib Data Sheet
- [ ] WCLM ________ Claim Worksheet
- [ ] WFEE ________ Fee Worksheet
- [ ] APPENDIX ________ Appendix
- [ ] COMPUTER ________ Computer Program Listing
- [ ] SPEC NO ________ Specification Not in English
- [ ] N417 ________ Copy of EFS Receipt Acknowledgement
- [ ] CRFL ________ Computer Readable Form Transfer Request Filed
- [ ] CRFS ________ Computer Readable Form Statement
- [ ] SEQLIST ________ Sequence Listing
- [ ] SIR. ________ SIR Request
- [ ] AF/D ________ Affidavit or Exhibit Received
- [ ] DIST ________ Terminal Disclaimer Filed
- [ ] PET. ________ Petition
- [ ] END JOB
- [ ] DUPLEX

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